(First Embodiment)

FIGS. 1A to 1C are cross sectional views showing the steps of manufacturing a semiconductor device according to a first embodiment of the present invention.

First, as shown in FIG. 1A, a base insulation film 2 is formed on a surface of a semiconductor substrate 1 having elements integrally formed thereon. Next, an interlayer insulation film 3 is formed on the base insulation layer 2 by using heating and the electron beam irradiation. A specific method for forming the interlayer insulation film 3 will be described later.

Next, as shown in FIG. 1B, a wiring groove with desired size and shape is formed at a predetermined portion of the interlayer insulation film 3, and a barrier metal 4 and a metal wire 5 are formed in a wiring groove by a conventional CMP process. In addition, the surface of the interlayer insulation film 3, barrier metal 4, and metal wire 5 is flattened. Here, a Cu wire whose main material is Cu is used as the metal wire 5.

Then, as shown in FIG. 1C, a barrier insulation film 6 having SiN or SiC is formed on the flattened surfaces of the interlayer insulation film 3, barrier metal 4, and metal wire 5.

Now, a method for forming the interlayer insulation film 3 will be specifically described. An outline

of the above process is given below (steps 1 to 4).

Step 1: A vanish is applied on a semiconductor substrate by using a spin coating technique.

Step 2: A heat treatment 80℃, one minute is applied to the substrate.

Step 3: A heat treatment 200℃, one minute is applied to the substrate.

Step 4: An electron beam is irradiated on the semiconductor substrate 1 while the semiconductor substrate 1 is heated in a reduced pressure nitrogen atmosphere, and the interlayer insulation film 3 is formed.

The above described process will be described in detail. First, a vanish obtained by dissolving polymethyl siloxane as a precursor of film material in solvent is applied with a spin coating technique using a coater, and a coat film is formed (step 1). For instance, the solvent is a PGPE (propylene glycol monopropyl ether).

Next, the semiconductor substrate is placed on a hot plate placed in a chamber that is the same as a reactor chamber for carrying out the electron beam irradiation treatment, and is held at 80℃. This state is held for one minute, whereby heat treatment is applied to the above coat film at 80℃ for one minute (step 2).

Next, while the semiconductor substrate 1 is

placed on the above hot plate, a temperature of the above hot plate is held at 200℃. This state is held for one minute, wherein heat treatment is applied to the above coat film at 200℃ for about one minute in a chamber that is the same as a reactor chamber for carrying out the electron beam irradiation treatment (step 3).

In accordance with the step 2 or step 3, the solvent contained in the coat film formed at the step 1 is removed, and the coat film is fixed on the semiconductor substrate 1.

Then, while the nitrogen gas is introduced into the reaction chamber about 20 slm, the semiconductor substrate 1 is placed on the hot plate held at 400℃ in the reduced pressure nitrogen atmosphere, the above coat film is irradiated with the electron beam, and the interlayer insulation film 3 is formed (step 4).

In the present embodiment, during the electron beam irradiation at step 4, the pressure in the reactor chamber is changed to 40 Torr and 60 Torr. That is, the electron beam irradiation is carried out by setting the pressure in the reactor chamber to 40 Torr and setting the quantity of incident electrons per unit time (irradiation quantity) to about 5 $\mu C/cm^2 \cdot sec$ for about 90 seconds from the start of the electron beam irradiation. Then, the electron beam irradiation is carried out by setting the pressure in the reactor